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~~Description~~

Apparatus for immediately outputting the response of a synchronous system to an asynchronous event

Background of the invention

The present invention relates to an apparatus ~~according to the precharacterizing clause of patent claim 1, that is to say an apparatus~~ for immediately outputting the response of a synchronous system to an asynchronous event.

A synchronous system is a system whose state changes only at specific (normally equidistant) times. Such a system is, for example, a digital circuit in which the sequential elements (the flipflops)~~,~~ and thus, the circuit containing the sequential elements as well, itself changes its state only during the rising or falling edge of a clock signal ~~flank~~, or shortly after it (delayed by the gate delay times). The times at which state changes can occur are referred to in the following text as defined state changing times.

In contrast to this, an asynchronous event is an event that ~~which~~ may occur at any time.

Since synchronous systems ~~(may)~~ react on certain occasions with a defined result to events that ~~is when said events~~ occur more or less precisely at the defined state changing times, it has been found to be advantageous for the asynchronous events (or ~~to be~~ more precisely ~~precise~~, the signals or signal changes which signal such events) to be synchronized (phased-in). This can be done, for example, by connecting a flipflop downstream from an ~~that~~ input connection via which the asynchronous event is fed into the system, with the input of the ~~this~~ flipflop and the asynchronous input connection of the synchronous system being connected to one another. Since signals applied to the flipflop input

are transferred to the flipflop output only on the rising or falling ~~flank~~ edge of a clock signal, a synchronous (phase-in) signal is available at the flipflop output.

This makes it possible to ensure that the synchronous system always reacts correctly to asynchronous events.

~~However, generally,~~ Generally, however, the synchronous system does not respond immediately to an asynchronous event, but with a greater or lesser delay, since synchronous systems can in fact change their state only at the defined state changing times.

However, in certain cases, it is necessary to react to the occurrence of an asynchronous event immediately.

In order to ~~allow this to be achieved when~~ achieve immediate reaction to asynchronous event ~~using~~ in a synchronous system, it is possible for those parts of the system to which asynchronous events are input and which ~~have to~~ must produce a response to these events~~,~~ to be operated asynchronously. The relevant system parts can be operated asynchronously, for example, by ~~at the same time~~ simultaneously using the asynchronous event as the clock signal for these system parts, as a result of which the elements in the relevant system parts switch at the same time that asynchronous events occur. In this ~~way~~ manner it is possible to respond to asynchronous events immediately. However, a problem in this case is that the synchronously operating part of ~~the system~~ and the asynchronous part of it change their states at different times and must be synchronized with one another in a complex manner.

Summary of the Invention

The present invention is thus based on ~~the~~ an object of developing ~~the~~ an apparatus ~~according to the precharacterizing clause of patent claim 1 such that it~~ that ~~is possible to react~~ reacts immediately to asynchronous events in a simple manner.

a. ~~This object is achieved~~ according to the invention by the features claimed in the characterizing part of patent claim 1, that is to say by an advanced calculation device by means of which the responses of the synchronous system to possible asynchronous events can be calculated in advance, and by a switching device by means of which the output signal from the advanced calculation device or the output signal from the ~~synchronous system can be passed~~ on selectively.

As a Result ~~In consequence~~, it is possible to continue operating the synchronous system "normally" and essentially ~~very largely~~ without any change. The fact that the system's response to asynchronous events takes place only after a greater or lesser delay after the occurrence of the asynchronous events is not disadvantageous since the capability to output a response calculated in advance by the advanced calculation device in the meantime affords ~~means that~~ the synchronous system the ability to ~~can in fact~~ react immediately and independently to asynchronous events. The currently determined response of the synchronous system need be only sufficiently early for the advanced calculation device to have sufficient time to calculate the response to the next asynchronous event in advance of the event occurrence ~~before said event occurs~~.

a2 ~~Advantageous developments of the invention can~~ be found in the dependent claims, the following description and the figure.

The invention will be described in more detail in the following text using an exemplary embodiment, and with reference to the figure.

The figure shows, schematically, the configuration of an exemplary embodiment of an apparatus for immediately outputting the response of a synchronous ~~system to an asynchronous event.~~

The apparatus described in more detail in the following description ~~text~~ contains a "normal" synchronous system, that is to say a system that ~~which~~ reacts synchronously to asynchronous events.

The asynchronous events or the signals which signal them are preferably synchronized or phased-in before being used by the synchronous system. To this end, the relevant event is delayed sufficiently such that it appears to the synchronous system as if the event had occurred at a defined state changing time. In the present case, this is achieved by connecting a flipflop downstream from the input connection via which the asynchronous event is input into the system, with the input of this flipflop and the asynchronous input connection of the synchronous system being connected to one another. Since signals that ~~which~~ are applied to the flipflop input are transferred to the flipflop output only with the rising or falling edge ~~flank~~ of a clock signal, a synchronous (phased-in) signal is available at the flipflop output. As a rule, it has been found to be advantageous for at least one further flipflop to be connected downstream from the flipflop. This ~~said flipflop; this~~ allows the occurrence of metastable states to be prevented.

In cases in which the synchronous system reacts correctly to the asynchronous events even without the ~~said~~ events being synchronized, it is, ~~of course,~~ possible to dispense with the synchronization of the asynchronous events.

In order to allow the system to react immediately to asynchronous events, the ~~said~~ system also has an advanced calculation device and a switching device. The ~~, with the~~ advanced calculation device is ~~being~~ designed to calculate the responses of the synchronous system to possible asynchronous events in advance and ~~with the switching device being designed to pass on~~ either the output signal from the advanced calculation device or the output signal from the synchronous system~~, optionally and selectively~~.

The fundamental configuration of such an arrangement is shown in the figure, with a ~~where the~~ synchronous system ~~is denoted by the~~

~~reference symbol~~ 1, the advanced calculation unit ~~device by the reference symbol~~ 2, and the switching device ~~by the reference symbol~~ 3.

The switching device 3 may be, for example, a multiplexer and, in the example under consideration, has input connections E1 and E2, an output connection A and a control connection C, with the first input connection E1 being connected to the output connection of the advanced calculation unit 2, and with the second input connection E2 being connected to the output connection of the synchronous system 1. The signal which is output at the output connection A of the switching device 3 is either the signal applied to its input connection E1 or the signal applied to its other input connection E2. A ~~the~~ control signal applied to the control connection C determines which of the input signals E1, E2 is passed on. The output signal A from the switching device 3 is, at the same time, the output signal from the entire apparatus. If ~~if~~ the signal (not shown in the figure) which is input into the apparatus is a signal signaling an asynchronous event, the output signal A from the switching device 3 represents the response of the synchronous system 1 to the asynchronous event.

The synchronous system 1 is the synchronous system which has already been described above.

As has already been stated above, the advanced calculation unit ~~device~~ 2 is designed to determine the response to an event in advance (i.e., ~~that is to say even~~ before the event occurs). If ~~if~~ more than one event can occur, the responses may ~~can~~ be determined for all the events or a selected number of events and can, at the same time, be applied to a plurality of input connections of the switching device 3 or, ~~if required and~~ alternatively, can be applied to the switching device 3 via one or a relatively small number of input connections to the switching device ~~it~~.

When an asynchronous event occurs, it is now possible for the response, calculated in advance by the advanced calculation unit ~~device~~ 2, to be output immediately; the ~~the~~ response (which is preferably permanently applied via a flipflop or the like) that ~~which~~ is produced at this stage at one of the input connections of the switching device 3 ~~just~~ merely has to be passed on by the switching device 3 to its output connection A, which can be done without any problem, at any time and with immediate effect, via its control connection C.

In the given circumstances, there is no reason for the synchronous system 1 to react asynchronously to the asynchronous event. Finally, the response to the asynchronous event is ~~in fact~~ output precisely at the time that it occurs. Nevertheless, the synchronous system also reacts to the asynchronous event and, in doing so, comes to the same conclusion as the advanced calculation carried out by the advanced calculation ~~device~~ unit 2.

As soon as the response of the synchronous system 1 occurs, ~~it~~ the response is applied to the input connection E2 of the switching device 3 and causes, via the control connection C, ~~said~~ the switching device 3 to pass this signal straight on to the input connection A.

Since the response of the synchronous system 1 to the asynchronous event and the response determined in advance by the advanced calculation unit ~~device~~ 2 are the same (they just originate from different sources), nothing changes at the output connection A of the switching device 3. However, in this way, the advanced calculation device can start to calculate the response to the next asynchronous event or the responses to the various next asynchronous events, in advance.

Although it is unnecessary for the synchronous system 1 to react immediately to the asynchronous event, it must not take an indefinite time to do so. The process of finding the response must

be completed sufficiently early so that the advanced calculation device still has sufficient time to calculate the response to the next asynchronous event~~,~~ or the responses to various asynchronous events~~,~~ in advance~~,~~ i.e., before they occur~~)~~.

Obviously, the apparatus described above can be used for widely differing purposes.

The asynchronous event~~,~~ or the signal which ~~signals it, may in this case also be used "just" as a~~ is a clock by ~~means of~~ which~~, for example,~~ data are output asynchronously from a synchronous system, for example. In this case, it is sufficient for the asynchronous event to be used to actuate the switching device 3 (to actuate ~~its~~ control connection C).

a ~~The~~ It is noted that the above described arrangement is not limited to ~~being dependent on~~ operating on only one asynchronous input signal~~; any~~. Any desired number of ~~(~~synchronous and/or asynchronous~~)~~ input signals may be taken into account. In this case, it is irrelevant whether the asynchronous input signals are in synchronism with one another.

a The above described apparatus is an electrical system ~~in the example described above~~. However, ~~it~~ the apparatus could also be an electromechanical or mechanical system. The above statements apply as appropriate to such systems~~; in~~ even this case, however, the terms "input and output signals" may mean mechanical states.

The described apparatus makes it possible for responses by synchronous systems to asynchronous events to be output immediately after said events occur.

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